KNOWLEDGE EXPECTATIONS FOR PEST CONTROL ADVISORS: NEMATODES

Be familiar with the following nematodes including common and scientific names, host range, life cycle, economic significance, damage symptoms, sampling and general management.

Anguina spp.: seed and leaf gall nematodes

Aphelenchoides spp.: foliar nematodes
- *A. fragariae*: strawberry bud nematode
- *A. ritzemabosi*: chrysanthemum nematode

Ditylenchus spp.: stem and bulb nematodes
- *D. destructor*: potato rot nematode
- *D. dipsaci*: stem and bulb nematode

Helicotylenchus spp.: spiral nematodes

Hemicycliophora arenaria: sheath nematode

Heterodera spp.: cyst nematodes
- *H. cruciferae*: cabbage cyst nematode
- *H. schachtii*: sugarbeet cyst nematode

Longidorus spp.: needle nematodes

Meloidogyne spp.: root-knot nematodes
- *M. arenaria*: peanut root-knot nematode
- *M. chitwoodi*: Columbian root-knot nematode
- *M. hapla*: northern root-knot nematode
- *M. incognita*: southern root-knot nematode
- *M. javanica*: Javanese root-knot nematode
- *M. naasi*: barley root-knot nematode

Mesocriconema spp.(previously *Criconemella* spp.): ring nematodes
- *M. xenoplax*

Nacobbus spp.: false root-knot nematodes

Paratrichodorus spp.: stubby-root nematodes

Paratylenchus spp.: pin nematodes

Pratylenchus spp.: lesion nematodes
- *P. brachyurus*: southern lesion nematode
- *P. coffeae*: coffee lesion nematode
- *P. neglectus*: root lesion nematode
- *P. penetrans*: northern lesion nematode
- *P. scribneri*: Scribner's lesion nematode
- *P. thornei*: Thorne's lesion nematode
- *P. vulnus*: walnut lesion nematode
- *P. zeae*: corn lesion nematode

Radopholus similis: burrowing nematode

Rotylenchulus reniformis: reniform nematode

Trichodorus spp.: stubby-root nematode

Tylenchulus semipenetrans: citrus nematode

Xiphinema spp.: dagger nematodes
- *X. americanum*
- *X. index*

I. NEMATODE DESCRIPTIONS

A. General Morphology

Describe the relative size of plant feeding nematodes.

Name five to six life stages of plant-parasitic nematodes.

Describe the shape and size of the following nematodes at different life stages:
- root-knot nematode;
- cyst nematode;
- lesion nematode.

Describe how shape of nematode affects the choice of extraction method.

Define vermiform.

Describe the major difference between the vermiform stage and other nematode life stages.

Describe the feeding apparatus of plant-parasitic nematodes and how it is used to feed on plants.

List two groups of nematodes by common name that exhibit sexual dimorphism.

Describe the differences in shape between males and females in nematodes that exhibit sexual dimorphism.

Describe how nematodes move.

B. Life Histories

List the major environmental/ecological factors that influence the time it takes a nematode to complete its' life cycle.

Identify the host(s) of some non-plant parasitic nematodes.

Define:

ectoparasite;
endoparasite.

List three ways ectoparasitic and endoparasitic species differ.

Identify by genus and common name the major ectoparasitic nematode groups.

Identify by genus and common name the major endoparasitic nematode groups.

List the two most economically important species of root-lesion nematodes on perennial crops in California by genus and species.

List the two economically important cyst nematodes in California by genus and species.

List five major root-knot nematodes in California by genus and species.

Compare and contrast the egg laying habits of:

ectoparasitic nematodes;
root-lesion nematodes;
stem and bulb nematodes;
foliar nematodes;
citrus nematodes;
root-knot nematodes.

Define and give an example of a:

sedentary ectoparasite;

migratory ectoparasite;
migratory endoparasite;
sedentary endoparasite.

Identify survival stages for the following nematodes:
stem and bulb nematodes;
cyst nematodes;
root-knot nematodes;
pin nematodes.

Describe how long the following nematodes can survive in the absence of living hosts:
stem and bulb nematodes;
foliar nematodes;
cyst nematodes;
root-knot nematodes.

II. NEMATODE DISTRIBUTION PATTERNS

A. Geographic Patterns

Describe how and why distribution patterns of different nematodes species vary.

Describe how nematode population levels fluctuate in an annual crop from harvest of one crop in fall to planting of another in spring and harvest of that crop in the next fall.

Describe how nematode populations fluctuate throughout the year on an established perennial crop.

Identify a nematode group whose distribution is mainly limited by soil texture in California.

List three reasons why root-lesion nematodes are widely distributed in California.

Describe how stem and bulb and foliar nematodes are distributed to new areas of the state.

Identify the major distribution determinant of:
citrus nematodes;
cyst nematodes.

Describe the impact of host preference on the distribution of the common root-knot nematode species.

B. Distribution within a Field

List two reasons why root-knot nematodes may be more severe in sandy soils.

List two ways irrigation practices can influence nematode patterns.

Describe how the following factors can influence distribution of some nematode species within the field:

- initial introduction site;
- soil type patterns;
- placement of infested plant material;
- cropping patterns;
- movement of agricultural equipment.

C. Nematode Dispersal

List the rate of self-dispersal of most nematode species.

Describe how nematodes move from field to field.

Describe the role of irrigation on inter-field distribution of nematodes.

Describe the value of quarantine in limiting the distribution of nematode species.

D. Vertical and Horizontal Distribution in Soil

Identify the primary factor that determines the vertical and horizontal distribution of nematodes in the soil.

Identify the site of greatest nematode population levels in:

- established orchards and vineyards;
- annual field and vegetable row crops.

E. Common Nematode-Crop Damage Associations

List the nematode groups most likely associated with the following crops:

- deciduous fruit trees;
- deciduous nut trees;
- citrus;
- grapes;
- vegetables;
- tomato;
- alfalfa;
- cotton;
- sugarbeets;
- lilies.

List the resources available to help PCAs determine what nematodes affect a given crop.

III. PLANT DAMAGE AND FIELD SYMPTOMOLOGY

A. Symptoms of Foliar and Stem and Bulb Nematodes

Describe the plant damage symptoms caused by foliar nematodes on ornamental and strawberry plants.

Describe the general plant damage symptoms caused by stem or bulb nematodes.

B. Symptoms of Root-Parasitic Nematodes

Describe the primary aboveground symptoms associated with root-parasitic nematodes on the following:

field and vegetable crops;
sugarbeets;
grapevines;
stone fruit and nut tree crops.

Identify other stresses that can cause the same type of symptoms as root-parastic nematodes.

Describe the root damage symptoms associated with root-knot nematodes.

List other pests or conditions that can cause root symptoms similar to root-knot nematode damage.

Describe the damage symptoms associated with cyst nematode and root-knot nematode on sugarbeets.

Describe the damage to roots caused by ectoparasitic nematodes.

Describe the common damage symptoms on the roots of trees infested with citrus nematodes.

Describe the damage on roots induced by root-lesion nematodes.

List the nematode species that can induce root proliferation.

Describe the association of root rotting and wilting organisms with root-knot nematode symptoms.

C. Disease Complexes

Describe the association between root-knot nematode and Fusarium wilt infection in cotton and tomatoes.

Identify the ectoparasitic nematodes that vector plant viruses and name the virus they transmit.

Identify the nematode associated with the bacterial canker pathogen of stone fruit trees in California

D. General Field Symptoms

List the common field symptoms of nematode damage in:
- established perennial plantings;
- annual plantings.

Describe and give an example of field conditions that can aggravate nematode problems.

Describe how the following provide general indications that nematodes may be damaging plants in the field:
- pocketed or irregular spots of poor growth;
- indigenous association with crop and location;
- sampling history;
- history of nematicide usage;
- crop susceptibility.

List the procedures PCAs should follow to identify and confirm a nematode problem.

Describe how PCAs can detect potential nematode problems before planting.

List two examples of economic injury levels for California nematodes.

List the factors to take into account when using quantitative assays to forecast future nematode damage.

IV. METHODS OF SOIL SAMPLING AND NEMATODE EXTRACTION

A. Sampling Considerations

Identify the appropriate time of sampling for:
- annual crops;
- vineyards or orchards;
- ornamental plantings or turf.

List the background information that should be included when sending a sample to a lab.

List the factors that determine the size of the sample to be taken.

Define sample size and list the number of soil cores that make up a basic minimum sample.

List the factors to consider when stratifying the field.

List the minimum cores/5 acres and the core depths for samples taken in:

field or row crops;
vineyards or orchards (preplant).

Describe how to take a sample in:

nursery stock;
a field.

Identify the tools necessary to take a:

soil sample;
root sample.

Describe how to package a soil sample.

B. Collection and Care of Samples

Describe how to collect field samples for:

established crops;
trees;
vineyards;
fallow fields.

Describe storage and shipping requirements necessary to send a soil sample to a lab.

C. Limitations of Soil Sampling

List the major limitations of using soil sample results for practical nematode predictions.

D. Selected methods for Recovery of Nematodes

Recognize the importance of telling the lab the previous, current and subsequent crop to help them determine the extraction method.

Recognize the importance of knowing the extraction procedure to interpret laboratory results.

Describe why ectoparasitic nematodes are not found in root samples.

Describe why root-knot nematodes may not be found in a root sample that has nematode galls on it.

E. Units for Reporting Nematode Populations

List the common units used to report nematode population levels from soil and from roots.

F. Extraction Efficiency

Describe the factors that influence the efficiency of the extraction method.

Explain extraction efficiency and its' importance in nematode sampling.

G. Interpreting a Lab Report

Identify the different extraction methods used by labs.

List the preferred extraction method for:
- nematodes of foliage or stems;
- dagger nematodes;
- cyst nematodes.

List the factors to consider in conjunction with every nematode sample.

Describe how to estimate the expected crop yield loss from the lab report.

V. MANAGING NEMATODE PROBLEMS

A. General Strategies

Define treatment threshold.

Describe the factors that influence the treatment threshold for nematodes.

List the resources for finding out methods for controlling nematodes in specific crops.

Describe the role of the California Nursery Certification program in preventing the spread of nematodes.

List methods used to prevent the spread of nematodes.

Describe the importance of cleaning equipment in limiting the spread of nematodes.

Describe the feasibility of eradicating 100% of nematodes from a field.

B. Specific Methods

Describe how crop rotations can be used to manage nematode populations.

Identify an example of a successful crop rotation program against a nematode pest in California.

Describe the use of degree-day models and how the manipulation of planting or harvest dates can be used to limit nematode damage.

Describe the role of weed control in rotation programs for nematode pest management.

Describe the impact of solarization on nematodes.

Describe how soil amendments can be used to reduce nematode damage.

Define "replant problem".

Describe how cover crops can impact nematode problems.

List four types of organisms known to attack nematodes in the soil.

C. Host Plant Resistance

Define:

resistance;
tolerance;
biotype.

Differentiate between host resistance and tolerance.

Understand the significance of the following rootstocks and cultivars in relation to host plant resistance:

Thompson seedless grape;
English, black and Paradox walnut;
Nemaguard and Lovell peach rootstocks;
Cowpea cultivar Blackeye 5;
Lima bean cultivar White Ventura N;
Blenhiem apricots;
VFN tomatoes.

List the factors that need to be considered when determining whether to plant a nematode resistant cultivar.

Describe and give examples of:

immune plants;
susceptible host plants;
nonhost plants;
resistant plants;
tolerant plants;
intolerant plants.

Describe the impact of biotypes or host races on nematode control.

Describe the benefits and limitations of using nematode resistant varieties in tomatoes.

List the pest management methods that discourage the breakdown of host plant resistance.

Describe the importance of crop rotation and sanitation when using resistant cultivars in alfalfa.

Describe the role of tolerant rootstocks and resistant cultivars in limiting economic damage from nematodes.

D. Nematicides

1. General Considerations

Compare/contrast the use of fumigants vs. nonfumigants.

Describe the factors that influence nematicide movement through the soil.

List some of the problems associated with the use of soil fumigants.

Define nematistat.

2. Specific Application Technology - Soil Fumigants

List ideal field conditions for the application of soil fumigants.

List the various methods available to evaluate soil fumigation.

Describe methods for evaluating a postplant nematicide application.

Describe methods for evaluating untested materials or new control methods.